# Science and Innovation in Water Management

During 2002 and 2003, the Wisconsin DNR participated in a number of research projects to enhance knowledge of watershed and contaminant transport processes, with the ultimate goal of refining and improving resource management and ecosystem health. Below are a few of these projects.

## Watershed Studies

### Development and Evaluation of Watershed Models for Predicting Potential Stream Condition and Making Land Use Decisions

The goal of this study is to develop and test models that quantify stream biological expectation and to predict how watershed land uses will influence the realization of this expectation. The approach used is to develop models that predict stream segment temperature, flow, and biological conditions based on climate, surficial geology, topography, soil, vegetation, and land uses for various regions of Wisconsin. These models are then linked to classify and map Wisconsin stream segments to explore how projected land-use changes may affect stream conditions for selected watersheds. Collection of field physical and biological data and developing GIS layers for watershed characteristics for this study is complete, and the data modeling process has begun.

These models can be used to classify stream reaches that lack adequate fish data and to estimate how watershed land-use has influenced thermal regimes, flow patterns, and fish communities across broad regions. Fisheries managers will be able to compare the expectations for a specific watershed with its current condition to determine its potential for improvement and to establish more realistic fishery goals. Planners can use these models to predict biological conditions under different landuse scenarios. Based on the stream classification, sampling and inventory efforts can be better allocated among watersheds and streams to maximize efficiency and statistical reliability for bioassessment.

### Evaluation of the Wisconsin Priority Watershed Program for Improving Stream Habitat and Fish Communities

This project was designed to determine the extent to which installation of best management practices (BMPs) improves the quality of aquatic resources. The study design is to sample habitat and fish communities using standardized procedures with known accuracy and precision at treatment and reference streams several years before and several years after BMP installation. And, two physical habitat (one for low and one for medium-high gradient) and two fish biological indices (one for coldwater and one for warmwater) have also been developed and tested. Fish and habitat data from 81sites on 33 streams for five priority watersheds and their reference watersheds during the past 14 years have been stored in a centralized database.

The evaluation of the Spring Creek Watershed, which demonstrated significant habitat and fish community improvements after BMP implementation, is complete and has been published. The evaluation of the Otter Creek watershed is also complete and in the publication process, but results were less than expected. Habitat conditions improved in Otter Creek, but fish communities did not. A likely reason the fish community did not change much is because the fish community was pretty good prior to the project and implementation of BMPs that would most directly influence the fish community (upland sediment control, riparian protection) were not implemented at a level high enough to elicit a response in the fish community

### Impacts of Watershed Urban Land Use on Coldwater Streams

This study was designed to develop models that describe relations between watershed urban land use and biological communities and to answer the question “at what level of watershed urban

development can a coldwater stream no longer support trout populations?" Thirty-nine (39) coldwater streams with different levels of watershed urban development for physical habitat, water temperature, base flow, fish, and macroinvertebrate were sampled. Urban land use in both riparian and watershed were digitized using GIS. This study is complete and published. R*esults indicate that stream base flow and biological indices decrease dramatically for watersheds with 7-11% impervious area, beyond which stream base flow is consistently low and biological indices are consistently poor*. Trout were not found in streams with more than 11% impervious surface area.

The models developed from this study can be used to predict stream quality for projected urban development, which can be used by policymakers, resource managers, planners, and developers to design strategies to minimize the impacts of urban development on coldwater streams.

# Monitoring & Management Studies

## Impacts of Phosphorus and Nitrogen Concentrations on the Biological Integrity of Wisconsin Stream

The objective of this project is to determine what phosphorus and nitrogen concentrations impair stream biological integrity; to develop a database that can be used to refine the phosphorus criteria for Wisconsin streams; and to determine how watershed characteristics affect the relation between phosphorus, nitrogen, and biological communities. DNR has has gathered data for nitrogen, phosphorus, other physical and chemical variables, periphyton, macroinvertebrate, fish, and physical habitat from 160 headwater streams, 80 larger but wadeable streams, and 40 nonwadeable streams/rivers. DNR gathered watershed land use and identified periphyton and macroinvertebrate community composition. Staff are now in the process of analyzing the data and the results will be available during this next reporting period.

The results of this study will be used to help interpret TMDL data and to refine nutrient criteria.

## Status Assessment and Development of a Fish Index of Biotic Integrity (IBI) for Small Warmwater Streams

The objectives of this study are to evaluate fish and habitat status and to develop a fish IBI for very small and intermittent warmwater Wisconsin streams. Ninety-eight (98) small warmwater streams throughout the state with different levels of impairment (from least to highly impacted) have been sampled for fish and habitat twice a year for two years. Watershed boundaries have been delineated and land use information for these stream catchments has been gathered.

The results from this study will provide information on fish and habitat conditions for these small warmwater streams, which is currently unknown. The IBI developed here will provide a tool for setting regulatory criteria and bioassessment for these types of streams.

## Comparison of Multi-level BMPs for Improving Stream Quality

This study is designed to evaluate if current levels of BMP installation improve stream habitat, fish, and macroinvertebrates and to examine if riparian buffer width has any influence on the upland BMPs effectiveness. Thirty-eight (38) small watershed streams with different levels of agricultural impairment and with different levels of BMP implementation (high impact - high BMP; high impact -low BMP; low impact - high BMP; low impact - low BMP) have been sampled. And, field data collection on fish, macroinvertebrate, and physical habitat is also complete. Riparian and watershed land use data has been gathered and watershed BMP implementation information is being assembled.

The results from this study can help researchers and managers understand if large-scale, low-level BMP implementation will improve stream quality. With this knowledge, resources can then be allocated more effectively.

## Development of a Probability-Based Stream Monitoring and Assessment Strategy

The purpose of this study is to find a cost-effective approach for better understanding the state's resource condition. This work will help stem the loss of stream resources and help improve under-

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standing of factors impacting water so that the state can more effectively monitor, assess and manage resources. The resulting information will be used to guide and evaluate stream resource assessment and management activities, and educate the public and political policy makers. This collaborative project is designed to: 1) determine whether three different methods used to select stream assessment sites significantly influence field data gathered to evaluate the condition of individual and populations of streams; 2) investigate how large-scale catchment attributes affect riparian and in-stream habitat and water chemistry, which in turn influence the biological integrity of streams; and 3) pilot the development of a multi-metric macroinvertebrate index for wadable streams in the driftless region ecoregion in western Wisconsin, and subsequently apply this process to develop a macroinvertebrate index for the entire state. The results of this study will be used to improve WDNR wadable stream monitoring and assessment program and advance and institutionalize the use of probability based monitoring in Wisconsin.

## Development and Validation of a Macroinvertebrate-Based Index of Biotic Integrity (IBI) for Low-Gradient Streams

Biotic assemblages in low-gradient streams are inherently different from those assemblages inhabiting medium to high gradient streams. Assessment tools developed through empirical modeling of data collected from medium to high gradient streams inaccurately score the ecological integrity of low-gradient systems. Therefore, we propose to tailor a macroinvertebrate-based IBI to low-gradient streams. Fifty-nine (59) sites will be used to develop the index and twenty-two (22) sites were set aside for validation. Watershed, reach, and local scale variables will be used to determine environmental conditions at the sites independently of the biota. Macroinvertebrate metrics that correspond with the independent assessment of environmental condition will comprise the IBI. The macroinvertebrate-based IBI tailored for low-gradient streams is intended for use in Wisconsin's Baseline Monitoring Program.